Captive maintenance of adults and juveniles of the genus *Triturus* during the terrestrial phase

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Two methods for maintaining newts during the terrestrial phase, such that regular recapture could be effected, were compared. The first method, which has been used previously by other workers for plethodontids, led to failure to thrive and absence of breeding condition during the following spring. The second method, which sought to mimic the natural terrestrial habitat of species of the genus *Triturus*, enabled efts to reach sexual maturity in one year and adults to subsequently come into breeding condition.

INTRODUCTION

The development of a method to maintain newts in the terrestrial phase, whereby individuals can easily be recaptured, is important for several reasons. Little is known about growth of juveniles or adults during this phase in the wild, mainly due to the difficulty of locating individuals (GRIFFITHS, 1984). Enhanced feeding of efts may lead to sexual maturity within one year which may assist reproductive studies on captive populations (BAKER, 1988; ELEBERT, 1991). However, raising juveniles to sexual maturity in one year may not be desirable for programmes where the newts are to be re-introduced into the wild, as it may impose unnatural selection pressures.

Newts, captured aquatically, can rapidly lose breeding condition. Males often react to the stress of capture by rapid regression of their crests or tail filaments and both sexes may cease courtship behaviour. VERRELL (1982) found that these reactions to stress in the male could be overcome in *Notophthalmus viridescens* by enhanced feeding but I found this regime to be unsuccessful for both *Triturus montandoni* and *Triturus helveticus* (unpublished data). Maintenance of adults during the terrestrial phase, enabling them to come into breeding condition the following spring, may facilitate studies of courtship behaviour in the laboratory.

Workers in North America have maintained plethodontids terrestrially, which enabled them to observe courtship behaviour for eight months of the year (SEVER & HOUCK, 1985). This method has also been successfully used to rear *Notophthalmus* efts (VERRELL, 1983).

Below, two methods are described, which were investigated for maintaining *Triturus* species during the terrestrial phase; the first method is based on that used for plethodontids and the second method is an attempt to mimic the natural terrestrial habitat of *Triturus* species.

Methods and results

First method

Adult *Triturus helveticus* were collected from a pond in Bedfordshire, England, and allowed to mate in tanks (30 cm × 60 cm × 38 cm high, size 1) at 14°C and on a natural photoperiod The resulting larvae were fed on *Daphnia* and *Tubifex*. At metamorphosis, the efts were transferred to small, round glass dishes (10 cm diameter × 4 cm high), lined with moist paper towel, containing crumpled paper for them to hide under and covered with "parafilm" to maintain the humidity and to prevent their escape. Each week the moist towel was renewed. The efts were kept at a density of six to a dish and maintained at 10-12°C with a 12L:12D photoperiod and fed on fruit flies (*Drosophila*) ad libitum.

After initially emerging from the water onto rocks, the adult newts were observed to re-enter the water several times before their skins reverted to the terrestrial velvety condition. They were then transferred to transparent boxes (17 cm × 31 cm × 9 cm high), at a density of four to a box and maintained under the same conditions as the efts.

The efts failed to thrive; they grew fast initially but then remained at a small size and subsequently died. None reached sexual maturity. The adults tended to lose weight during the terrestrial phase, appearing very thin and dark skinned; none came into breeding condition the following spring

Second method

Triturus alpestris adults were collected in France in 1989, in breeding condition. They were housed in aquaria (size 1) and maintained at 12°C on an artificial photoperiod that replicated the natural photoperiod (condition A). The resulting larvae were fed on *Daphnia* and *Tubifex*. Ten larvae metamorphosed during late summer.

Triturus montandoni adults were collected in Poland in 1990, in breeding condition. However, when they reached the laboratory, the males' tail filaments had regressed and they failed to court. The females, which had been ovipositing prior to capture, failed to deposit any more eggs. Within a few weeks the adults left the water, via rocks emerging from it, and were transferred to a terrarium.

The efts and adults were kept in terraria consisting of transparent plastic tanks (21 cm × 40 cm × 25 cm high) covered with a plastic lid containing mesh over the air holes. A layer of earth, 5 cm deep, was put in the bottom of the tank. Dry leaf litter, which contained small invertebrates (wood lice, ants, beetles, etc.), was placed on top of the earth until the tank was half-full, followed by several large stones and some pieces of bark for the newts to hide under. The terraria were maintained so that the soil base was always moist and the leaf litter dry. Each terrarium contained up to ten efts or six adults, which were fed on *Drosophila* (flies and maggots) and white worms (*Enchytraeus albidus*) ad libitum, and maintained at 19-23°C with a natural photoperiod. One corner of the terrarium was used to maintain the white worms, which were replenished regularly.

In December, the terraria were transferred to condition A, to simulate winter, and fed as above. In February, when *Triturus vulgaris* were migrating to the ponds locally, the adult *T. montandoni* were transferred to aquaria (size 1), filled to a depth of 15 cm, and kept in an unheated shed with a natural photoperiod. The *T. alpestris* efts had also thrived and their skins now appeared damp, so they were transferred to tanks identical to the above. The newts were placed on bricks above the water level.

In the terraria, the newts were often found clustered together under a piece of bark and the efts were found inside the curled leaves. The adults were also found buried in the soil, however they could still be seen foraging during the late afternoon and evening.

Within a few days of transfer, the adult *T. montandoni* became aquatic. Subsequently, five of the six came into breeding condition, courted and reproduced. Six juvenile *T. alpestris* became aquatic during the first day. They also came into breeding condition but, as all the juveniles were female, no courtship was observed.

DISCUSSION

Looking at the results described above, it appears that the regime used in North America so successfully for plethodontids is inappropriate for *Triturus* spp. In the first method, although the absolute humidity may change as the week progresses due to the moist towel drying out, the humidity is uniform throughout the box. Little is known about the humidity preferences of terrestrial newts; therefore, the humidity achieved in the box may be unsuitable. The diet in this method is also very uniform. SMITH (1951) described the terrestrial diet of newts as consisting of worms, slugs, snails and insects; therefore, it is possible that the newts are being deprived of essential nutrients when fed solely on a single species of insect.

The second method was equally successful for maintaining both efts and adults. The terrarium was set up so that a humidity gradient existed within it and the newts appeared able to find an appropriate microhabitat. The diet was more varied, the newts were fed on *Drosophila* (flies and maggots), white worms and any invertebrates in the soil and leaf litter. This diet may be closer to that found in the wild and is therefore more likely to supply all the nutrients necessary for spermatogenesis and somatic growth. This method also gave the newts a period of "summer" terrestrial conditions which has been shown to be a requirement for complete spermatogenesis to occur (SAEZ et al., 1992). The lack of this "summer" period in the first method may have contributed to the decline of the newts and may indicate that efts also require these higher temperatures for development.

Development of a method that facilitates recapture in the terrestrial phase may allow investigation of differential feeding and growth rates during this phase. Age accounts for only a small proportion of the total variance in adult body size (HALLIDAY & VERRELL, 1988) and therefore a study of juvenile growth during this phase may help to elucidate further the variation in subsequent adult body size. BAKER (1992) has shown that crest height is related to body condition in *Triturus cristatus*. The above method will enable a study to be undertaken to investigate the relationship between growth and body condition in the terrestrial phase to the development of secondary sexual characteristics and subsequent reproductive success in the aquatic phase.

Résumé

Deux méthodes pour le maintien en captivité de tritons pendant leur phase terrestre sont décrites et comparées. La première méthode, qui a été déjà utilisée avec succès avec des Pléthodontidés, a abouti à un échec en ce qui concerne la croissance des animaux et leur aptitude à se reproduire au printemps suivant. La deuxième méthode, qui cherche à reproduire l'habitat terrestre naturel des espèces du genre *Triturus*, a permis aux jeunes tritons d'atteindre la maturité sexuelle en un an et aux adultes de retrouver leur condition reproductive au printemps.

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Literature cited

Baker, J. M. R., 1988. — Maintenance and breeding of *Triturus karelini*. *Brit. herp. Soc. Bull.*, **25**: 42-44.

----- 1992. — Body condition and tail height in great crested newts, *Triturus cristatus*. *Anim. Behav.*, **43**: 157-159.

Elebert, E., 1991. — Precocious newts. *Brit. herp. Soc. Bull.*, **35**: 17-19.

Griffiths, R. A., 1984. — Seasonal behaviour and intrahabitat movements in an urban population of smooth newts, *Triturus vulgaris* (Amphibia: Salamandridae). *J. Zool., Lond.*, **203**: 241-251.

Halliday, T. R. & Verrell, P. A., 1988. — Body size and age in amphibians and reptiles. *J. Herp.*, **22** (3): 253-265.

Saez, F. J., Fraile, B., Paz de Miguel, M. & Paniagua, R., 1992. — Effects of low temperature on testicular cells in the marbled newt, *Triturus marmoratus* (Caudata, Salamandridae). *Herp. J.*, **2**: 125-132.

Sever, D. M. & Houck, L., 1985. — Spermatophore formation in *Desmognathus ochrophaeus* (Amphibia: Plethodontidae). *Copeia*, **1985**: 394-402.

Smith, M., 1951. — *The British amphibians and reptiles*. London, Collins: 1-318.

Verrell, P. A., 1982. — A note on the maintenance of the red spotted newt in captivity. *Brit. herp. Soc. Bull.*, **5**: 28-29.

----- 1983. — A note on the breeding of the red-spotted newt in captivity. *Brit. herp. Soc. Bull.*, **6**: 48-49.

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